When clouds cover the sky the greater part of the solar rays can not reach the earth's surface, and the nocturnal radiation of heat from the earth is also hindered. The effect of clouds is, therefore, to diminish the amount of the heat exchange in the upper layer of the earth's crust. In order to see what difference occurs in the heat exchange in the snow layers under consideration on clear and cloudy days I have computed the amounts of exchange in two selected days. As the clear day I have selected February 17, and as the cloudy day, February 23. The mean amount of cloud is 0.8 on the former day, and 9.7 on the latter day. On both days the diurnal temperature wave penetrated below the depth of 30 centimeters. The range of the temperature at this depth was 1.7° on the clear day, and 1.2° on the cloudy day. Hence, in calculating the variations of heat content the quantity of heat which flowed across the plane at 30 centimeters below the surface of the ground must be taken into account. But I have abstained from making such corrections in my computations, since the correction is certainly a small quantity, at most about 5 per cent of the total amount, and in such a discussion as the present one a knowledge of only the order of the required value is sufficient for my purpose. Strictly speaking, therefore, the result obtained below is to be regarded as the diurnal heat exchange taking place in the uppermost 30 centimeters of a deep layer of snow.

Table III contains the amount of the heat exchange on the clear day, and Table IV that on the cloudy day.

TABLE III.—*Heat exchange (gram-calories) in snow on clear day.*

Time interval.	Depth in centimeters.				
	0-5	5-10	10-20	20-30	Total.
Midnight to 1 a.m.	−0.30	−0.64	−0.63	−0.28	−1.85
1 to 2 a.m.	−0.35	−0.77	−0.58	−0.41	−2.11
2 to 3 a.m.	−0.10	−0.50	−0.52	−0.28	−1.40
3 to 4 a.m.	−0.21	−0.50	−0.58	−0.28	−1.57
4 to 5 a.m.	−0.17	−0.55	−0.52	−0.34	−1.58
5 to 6 a.m.	−0.21	−0.50	−0.46	−0.34	−1.51
6 to 7 a.m.	−0.05	−0.27	−0.29	−0.21	−0.82
7 to 8 a.m.	+1.09	+0.86	−0.23	−0.28	+1.44
8 to 9 a.m.	+1.66	+1.91	+0.40	0.00	+3.97
9 to 10 a.m.	+1.67	+2.73	+0.63	−0.28	+4.75
10 to 11 a.m.	+1.78	+2.64	+1.15	−0.14	+5.43
11 a.m. to noon	+0.60	+1.00	+0.69	0.00	+2.29
Noon to 1 p.m.	+0.47	+1.64	+1.09	+0.14	+3.34
1 to 2 p.m.	+0.37	+1.05	+0.86	0.00	+2.28
2 to 3 p.m.	−0.51	+0.41	+0.69	+0.21	+0.80
3 to 4 p.m.	−0.46	−0.41	+0.40	+0.21	−0.26
4 to 5 p.m.	−1.16	−1.14	−0.58	+0.14	−2.74
5 to 6 p.m.	−0.70	−1.14	−0.23	+0.21	−1.86
6 to 7 p.m.	−0.95	−1.23	−0.35	+0.07	−2.46
7 to 8 p.m.	−1.09	−1.64	−0.46	+0.14	−3.05
8 to 9 p.m.	−0.54	−1.18	−0.58	+0.14	−2.16
9 to 10 p.m.	−0.32	−1.09	−0.75	−0.14	−2.30
10 to 11 p.m.	−0.28	−0.59	−0.63	−0.28	−1.78
11 p.m. to midnight	−0.46	−0.82	−0.52	0.00	−1.80

TABLE IV.—*Heat exchange (gram-calories) in snow on cloudy day.*

Midnight to 1 a.m.	−0.12	−0.45	−0.35	+0.14	−0.78
1 to 2 a.m.	−0.02	−0.05	0.00	+0.07	0.00
2 to 3 a.m.	+0.14	+0.09	−0.06	0.00	+0.17
3 to 4 a.m.	+0.14	+0.14	0.00	0.00	+0.28
4 to 5 a.m.	+0.05	+0.27	+0.17	+0.07	+0.56
5 to 6 a.m.	0.00	−0.09	0.00	+0.14	+0.05
6 to 7 a.m.	+0.10	+0.18	+0.17	+0.07	+0.52
7 to 8 a.m.	+0.30	+0.36	+0.12	+0.21	+0.99
8 to 9 a.m.	+0.46	+0.77	+0.29	0.00	+1.52
9 to 10 a.m.	+0.65	+1.00	+0.46	+0.14	+2.25
10 to 11 a.m.	+0.40	+0.91	+0.63	+0.21	+2.15
11 a.m. to noon	+0.16	+0.68	+0.46	0.00	+1.30
Noon to 1 p.m.	+0.26	+0.50	+0.35	+0.14	+1.25
1 to 2 p.m.	−0.28	0.00	+0.40	+0.34	+0.46
2 to 3 p.m.	−0.63	−0.59	+0.06	+0.14	−1.02
3 to 4 p.m.	−0.60	−0.86	−0.17	+0.07	−1.56
4 to 5 p.m.	−0.62	−1.05	−0.36	+0.07	−1.96
5 to 6 p.m.	−0.26	−0.45	−0.17	+0.14	−0.74
6 to 7 p.m.	−0.16	−0.55	−0.29	+0.07	−0.93
7 to 8 p.m.	−0.19	−0.36	−0.23	+0.07	−0.71
8 to 9 p.m.	−0.10	−0.41	−0.29	−0.07	−0.87
9 to 10 p.m.	−0.21	−0.36	−0.35	−0.14	−1.06
10 to 11 p.m.	−0.23	−0.36	−0.12	0.00	−0.71
11 p.m. to midnight	−0.46	−0.64	−0.40	−0.14	−1.64

The total amount of the heat exchange is 24.3 gram-calories on the clear day, and 11.5 gram-calories on the cloudy day. The former is double the latter.

A BIOGRAPHICAL SKETCH OF PROF. DIRO KITAO.

By Dr. S. TETSU TAMURA, Professor of Meteorology and Ocean Physics, Naval Staff College.

[Extract from a memoir, printed in the Journal of the Meteorological Society of Japan, September, 1907.]

* * * Whatever the definition of human greatness may be, it can not be denied that all great men of science have made great and wonderful discoveries, and have inspired their pupils and followers to a nobler ambition, as contributors to the sum of human knowledge. Here in Japan we find an excellent example of such a man in Professor Doctor Kitao, the profound mathematician and original thinker, who has just past away from us (on September 7, 1907), but whose masterful work has left a lasting impression on the progress of theoretical meteorology and mathematical physics.

Prof. Diro Kitao was born in Matsue in the province of Izumo, on the fourth of July of the memorable year 1853 when Commodore Perry first visited Uraga. His father, who was a physician, was called Kwanyu Matsumura, and the early name of Professor Kitao was Rokujiro Matsumura. Young Rokujiro, or Diro, as he was called later, early developed a bent for serious study, and at such a youthful age as ten his rare gifts marked him out as a genius of great promise. It is said that, when yet so young, he already became a master of Chinese classics and history, and wrote several beautiful poems. The attention of Zenichiro Kitao, then a famous scholar of the Dutch language, was attracted by the precosity of the young boy, and finally the elder scholar adopted him and sent him to the schools in Tokyo and Osaka. After some preliminary training at both these places, Diro Kitao was, in 1870, sent by the government to Germany for study. He went thru the gymnasium at Berlin in 1873 and then entered the University of Berlin to study mathematical physics under Helmholtz. Later he was identified with Göttingen University, where in 1879 he wrote a remarkable inaugural dissertation, "Farbenlehre", and took the degree of doctor of philosophy with honors. Doctor Kitao continued his study in Germany for four more years, and it was in one of those years that he invented the Leukoskop and that he met the present Frau Louise Kitao and was married to her. After an absence of fourteen years he returned to his native land with his German wife. During his long stay in Europe Doctor Kitao experienced a great many pecuniary difficulties and even adversities; for tho for the first one or two years he was supported by the Japanese Government, later he had, owing to a change of our governmental system, to support himself by teaching mathematics to lower students or by writing for German magazines and newspapers. It is said that an American Consul to Germany, Mr. Mayer, was greatly interested in Doctor Kitao and assisted him in many useful ways. How hard it is for one to be in such circumstances in a strange country can scarcely be realized except by experience.

The result of his hard study and perseverance was made apparent when, on his return to Japan in 1884, Doctor Kitao was appointed lecturer and soon after promoted to the professorship of physics, in the Imperial University of Tokyo. It was still more apparent when, in 1886, he was appointed professor of physics in the Tokyo Agricultural School and, in 1888, professor of meteorology in the Naval Staff College, while retaining his older position in the Imperial University. In 1890 the Tokyo Agricultural School was made a part of the Imperial University as the Agricultural College, and Doctor Kitao became professor of forest physics and meteorology in the college. This last position he held till recently. In 1891 he received the honorary degree of doctor of science from the university.

The following is the record of his published papers:

1. Zur Farbenlehre.
(Eine Inaugural-dissertation. Berlin, 1879).

2. Leukoskop, seine Anwendung und seine Theorie.
(Abhandlungen des Tôkyô Daigaku. Universität zu Tôkyô). No. 12, p. 1-102. 1885.
3. Beiträge zur Theorie der Bewegung der Erdatmosphäre und der Wirbelstürme. The Journal of the College of Science, Imperial University, Tokyo.
Erste Abhandlung. Vol. I, Part II, 1887, p. 113-209.
Zweite Abhandlung. Vol. II, Part V, 1889, p. 229-412.
Dritte Abhandlung. Vol. VII, Part V, 1895, p. 293-402.
4. Ueber die Darstellung der Analytischen Gleichungen für Nicht Homogene Curven und Flächen.
Tōkyō Sūgaku-Buturigaku kwai Kizi. Maki no. V, Dai 3, 1894, p. 136-166.
5. Ueber die Integration der durch die Fourierschen Doppelintegrale darstellbaren Discontinuirlichen Functionen. Ditto, p. 167-174. 1894.
6. Eine Methode, Mittelst zweier rechtwinkeligen lineale Cubikwurzel zu finden. Ditto, p. 175-176. 1894.
7. Ueber die Transformation des Ausdrucks $\Delta\phi$ aus linien, welche die Oberflächen ϕ=const. senkrecht durchsetzen. Ditto, p. 177-180. 1894.
8. Ueber das Gesetz der Reibung. Ditto, p. 181-189. 1894.
9. Ueber die electrischen Messungen. Ditto, 190-214. 1894.
10. Ueber die Wasserbewegung in Böden. Bulletin, Vol. III, No. 1, p. 1-113. College of Agriculture, Imperial University. 1897.
11. Ueber Schwinden und Quellen der Hölzer. Ditto, Vol. III, No. 4, p. 299-270. 1898.
12. In wie ferne kann man das Holz als ein isotroper Körper betrachten? Ditto, Vol. V, No. 1, p. 1-39. 1902.

The most important work of Professor Kitao is, no doubt, his "Beiträge zur Theorie der Erdatmosphäre und der Wirbelstürme", comparable with the elegant analysis of Oberbeck and Helmholtz, in fact reminding us remarkably of the work of Kirchhoff. This elaborate memoir, which covers some four hundred pages, was published in three volumes, Volume I in 1887, Volume II in 1889, and Volume III in 1895, in the Journal of the College of Science of the Tokyo Imperial University. On account of its great length and of its highly mathematical nature, it is impossible to reproduce here all its important results; but it may be worth while to give the title of each part. The first volume (§ I-VII) contains the introduction and the discussions of hydrodynamic equations with consideration of the earth's rotation; the general differential equations for the motion of the atmosphere; the general relations between isodynamic lines, wind-directions and vortex-axes; space integration; the equations of atmospheric motions under special assumptions; vorticular motions of the atmosphere; circular cyclones and anticyclones. The second volume (§ VIII-XI) treats of a vortex field of rectilinear isobars; the formation of complex vortices in the atmosphere; special motion in a vortex field; the change of wind-direction, strength, and pressure for a given external point in the case of a double vortex formation. The third volume (§ XII-XIV) treats of the condition for a stationary vortex when two vortices exist; vertical atmospheric circulation; variable vortex formation in the atmosphere. One great characteristic of all the work of Professor Kitao was the reduction of the number of hypotheses to the fewest possible. From this point of view it seems to be the surest guarantee of the permanency of his work.

Why is it that the advancement of modern meteorology is so slow? Is it because of the lack of complete meteorological data, notably in the upper regions of the atmosphere, or because of the complexity of atmospheric phenomena? Will natural difficulties never yield to mathematical analysis until new methods of analysis shall have been developed? Whichever the case may be, meteorology needs for its future advancement the highest mathematical ability, like that of Professor Kitao. During the last quarter of the nineteenth century a vast mass of meteorological observations was piled up, and this accumulation is going on without end and at great expense in every civilized country. A man of mediocre ability can observe and collect facts, but it takes the exceptional man of great mathematical and logical power to draw legitimate theories or conclusions from observations, or to work out the best results from them. Observers and practical meteorologists

express the results of their observations by graphic methods; but such methods are entirely destitute of generality, so that if we take analytical theory from the present meteorology we shall leave little but a heap of unrelated facts. The remarkable work of Professor Kitao, however, tells us that mathematical analysis discovers the hidden chain which unites facts so widely distant from each other that ordinary reasoning could not even suspect their connection. True, such scientific achievements are not, perhaps, of the type which most easily commands general attention. They have not yet been utilized in weather-forecasting or in storm-warning. Moreover, the papers written in difficult mathematical language can not be read easily. These may be the very reasons why Doctor Kitao's papers have been read by only a small group of scientists. But such investigators are greatly needed in the future advancement of modern meteorology. By his untimely death the world of meteorology has sustained one of its greatest losses.

Here, however, I must cut short this inadequate account of what the scholar did, that I may say a word or two of what the man was. The extraordinary powers of mind of Professor Kitao were illustrated by the fact that while he accomplished in the difficult fields of mathematics, physics, and meteorology enough to secure his lasting fame, he was able to turn his attention to an entirely different field, the domain of literature and arts. In the first place, Doctor Kitao was an excellent German writer. The fact may clearly be recognized in all his writings and especially in his profoundly interesting novel, "Waldsnymphe", which is left unpublished. This splendidly written German novel consists of fifteen volumes of about one thousand octavo pages each, illustrated with one hundred beautiful pen pictures of his own. Professor Kitao was also a good musician, and especially a skilful pianist; he was a very happy man when playing on the piano with Frau Kitao in the evening. Thus it may be seen that Doctor Kitao was a man of many attainments. He was at once a great mathematician, physicist, and meteorologist, while he was also an excellent writer, painter, and musician. Altho a man of the quietest and simplest manner and of the highest character, he often changed into an eloquent speaker, and no one could meet him without feeling the charm of his personality, when his interest was once aroused in any subject. Professor Kitao was always kind and cordial to his students; moreover his great originality and extraordinary powers of intuition made his lectures most inspiring to advanced students.

Unfortunately I was so young before I went abroad that I had scant opportunity to be personally acquainted with the great scholar himself, and when I returned to Japan, after an absence of nine years, Professor Kitao was seriously ill and had already given up his active service to science. But he has been an ideal teacher, a source of inspiration to me, during the last fifteen years. When I was yet a pupil in a middle school, I learned for the first time the name of Doctor Kitao as a great mathematician. While a student at Aoyama, I often saw a large and distinguished-looking man pass by our school; and when I was told that he was Doctor Kitao returning home from his college, one can hardly imagine how happy I, a poor boy but a student of mathematical turn, was! It was, indeed, my daily enjoyment, tho childish, to stand by my window and watch the great mathematician walk or ride on the avenue along our campus. I had also a good opportunity to read the splendid lectures on higher mathematics delivered by Professor Kitao thru the courtesy of a friend who was one of his students at the College of Agriculture. My greater admiration of him, however, was excited far away in America and Europe. When I was studying mathematical physics and later meteorology under Gibbs, Woodward, and Abbe, and when I met many eminent scientists, the name and work of Doctor Kitao were always highly praised, and I felt as proud of him as if my own master was lauded to the sky. It was especially his American friend, Prof. Cleveland Abbe, who aroused my interest in meteorology and called my attention to his great meteorological work. Just a year ago I returned to Japan with great enthusiasm and sweet anticipation of seeing our eminent mathematician and meteorologist and of studying under his personal guidance; but alas! I found him intellectually dead. It is, however, a great privilege and honor to me that I now hold the chair of meteorology at the Naval Staff College which Professor Kitao once occupied and that the task of writing his memoir has fallen to my hand.

It is certainly a great misfortune that both his greatness and his work, like those of my former master, Professor J. Willard Gibbs, were not fully appreciated in the world, and were really very little known to laymen as well as to scientists in Japan. * * *

H. C. RUSSELL.[1]

The announcement of the death of Mr. H. C. Russell, who for nearly forty years was among the foremost representatives of science in the colony of New South Wales, has been received with great regret by many men of science. Since 1870 he held the post of government astronomer and director of the Sydney Observatory, in succession to Mr. G. R. Smalley, and in that capacity rendered most important services to the colony. His first duty on appointment was to organize the resources of the colony for the observation of the transit of Venus. With small funds, little skilled assistance, and short time for preparation he nevertheless succeeded in equipping several stations in a highly efficient manner, reflecting great credit upon the readiness of the colonists and the exertions of the observatory staff.

Thenceforward the observatory pursued a course marked by continually increasing usefulness, culminating in the acceptance of a share in the international photographic chart of the heavens. * * *

But most of all the colony is indebted to him for his organization of the meteorological service. He had charge of a district of the climate of which little was known, and as the colony extended and the population occupied areas of unexplored country, he had to widen the range of his inquiry in order to supply the necessary information to intending settlers. The long series of observations that he published on climate factors, especially those having reference to rain, evaporation, and state of the rivers, attest to his industry, his powers of organization, and his recognition of the requirements of a young and rising colony. He put it on record that when he assumed office there were but five rain-gauges in the colony. On his retirement there were something like two thousand. His discussion of the results has scarcely been as happy as his collection. He seems to have relied upon statistical methods rather than on physical facts, and in this way was led to suggest a theory which would make the amount of precipitation depend upon the moon's nodes. These cycles are shown very distinctly over the few years that he was able to bring under discussion, but his explanation has not been generally accepted. This is a small matter in comparison with the value of the information which he was able to furnish, and which has contributed in no small degree to the prosperity of the colony. This collection of observations will be of the greatest service in subsequent inquiries.

Mr. Russell has left a character for industry and closeness of application that can not but prove stimulating to future astronomers in the southern hemisphere. He was much esteemed by many friends in this country, who regretted his retirement from the observatory; and besides being a Fellow of the Royal Society, to which he was elected in 1886, he was a member of many learned bodies, and was well known as a contributor of frequent and welcome papers.

[1] Part of an obituary notice signed "W. E. P.", printed in Nature (of London), issue of March 7, 1907. Mr. Russell was a member of the International Meteorological Committee. His death occurred at Sydney, Australia, February 22, 1907.—EDITOR.

AN IMPORTANT METHOD IN AERIAL RESEARCH.

As many individuals in this country wish to do something in connection with the recent development of the study of the free air, the Editor takes pleasure in commending to their attention the following translation of an article by Doctor de Quervain, the enthusiastic assistant to Professor Hergesell as secretary of the International Union for Aerial Research. De Quervain's success in Europe in keeping sight of a small balloon (with the help of a special telescope) demonstrates that still better work can be done in the clear air of our prairies and mountain plateaus, where especially we need to know more about the upper currents, and where de Quervain's methods are the least expensive and troublesome of all as yet devised.

In this connection it is worth noting that the need of a better knowledge of the upper currents, the altitudes of clouds, etc., led the Editor to urge the use of pilot balloons in 1871, but an adverse report hindered the work. In 1872 he fitted out the *Florence* arctic expedition with the necessary instructions, including the method for determination of the vertical velocity at each ascension, but it afterwards appeared that the hydrogen gas apparatus was left on shore at New London. In 1889 he carried a large supply of balloons on the cruise of the *Pensacola* round the Atlantic, but the carboy of sulfuric acid frequently made trouble on the deck of the vessel and was soon thrown overboard, so that the work had to stop. (An order to send the carboy "below" was interpreted by the crew to mean "Davy Jones's locker"!)

There are many difficulties in store for us, but we must do the best to overcome them, and make every possible effort to use balloons and kites in the study of the atmosphere. A convenient apparatus for filling small balloons with hydrogen can be bought of the dealers in New York, N. Y., and many chemical laboratories have something equivalent. We hope to hear of these being used for meteorological work.—*C. A.*

A PROPOSAL THAT PILOT BALLOONS BE MORE GENERALLY USED IN MAKING METEOROLOGICAL OBSERVATIONS.

By Dr. A. de QUERVAIN. Translated from Das Wetter, May, 1906, by Dr. C. Abbe, jr.

In investigating the free air it is just as important to have a knowledge of the direction and velocity of the air currents at different levels as it is to know the distribution of temperature. In many cases accurate cloud observations yield us fairly accurate information concerning the directions of these currents. Such observations are yet more valuable if the observatory is also in a position to measure the altitudes of the clouds.

On fine clear days the atmospheric currents even at great altitudes may be studied most advantageously by determining trigonometrically the course of a sounding balloon with the aid of some appropriate instrument. Such a series of observations presented so many practical difficulties, especially in the case of Assmann's rubber baloons, which are now generally used, that until recently no one had undertaken them. Since the accurate study of atmospheric currents has long seemed to me to be of the greatest importance, I have, during the past five years, made numerous practical attempts to work out a method for doing this. Finally, with the support of the firm of J. and A. Bosch, of Strassburg, I succeeded in constructing a special theodolite[1] by the aid of which I found it possible on clear days to determine the path of a sounding balloon with certainty and convenience up to altitudes of over 16,000 meters, and to horizontal distances of over 60 kilo-

[1] See the detailed description in Zeits. Inst'kunde, 1905, p. 135; and Met. Zeit., 1906, p. 149.